ABSTRACT

Provided is a thermoplastic resin composition comprising a combination of 5 to 89.95 mass % of an aromatic polycarbonate resin (A), 5 to 60 mass % of an aliphatic polyester (B), 5 to 30 mass % of talc (C), 0.05 to 3 mass % of a functional group-containing silicone (D), and 0 to 2 mass % of polytetrafluoroethylene (E) at a total content of the components (A) to (E) of 100 mass %, in which a mass ratio of the component (D) to the component (B) is 0.003 to 0.6. The thermoplastic resin composition has remarkably improved flame retardancy and impact resistance, has excellent chemical resistance and heat resistance, and provides a molded article having an good external appearance. Also provided is a molded article obtained by using the thermoplastic resin composition.
Fig. 1
THERMOPLASTIC RESIN COMPOSITION, AND MOLDED ARTICLE

TECHNICAL FIELD

[0001] The present invention relates to a thermoplastic resin composition and a molded article, and more specifically, to a thermoplastic resin composition which is suitable as, for example, parts for OA instruments, electrical and electronic instruments, and communication instruments, has excellent flame retardancy and excellent impact resistance, and is excellent in chemical resistance and heat resistance and provides a molded article having a good external appearance, and a molded article of the thermoplastic resin composition.

BACKGROUND ART

[0002] Polycarbonates have been frequently utilized in an automobile field, and electrical and electronic fields because of their excellent heat resistance and excellent impact resistance. In the automobile field, and the electrical and electronic fields, thinning has been progressing as a result of the weight reduction of a product, and a blend of a polycarbonate and an ABS resin or AS resin has gone mainstream in order that the fluidity of the polycarbonate may be improved. Blending the ABS resin can improve not only the fluidity but also the impact resistance and chemical resistance. Alternatively, the chemical resistance can be improved by turning a polyester and the polycarbonate into an alloy.

[0003] In recent years, the development of the following plastic products has also been progressing. That is, a product ratio in each of the products is increased by compounding a plant-derived component, and the products show consideration for an environment. Aliphatic polyesters, and copolymers of the aliphatic polyesters and other polyesters are in the mainstream of plant-derived plastics, and the addition of any such plastic to a polycarbonate can improve the fluidity and the chemical resistance. The development of a resin composition blended with a polyactic acid out of the aliphatic polyesters has been progressing because of the heat resistance and durability of the polyactic acid.

[0004] For example, a technology involving adding a phosphate to a resin composition formed of a polycarbonate and a polyactic acid to improve flame retardancy has been proposed (see, for example, Patent Documents 1 and 2). However, the addition of the phosphate reduces the heat resistance of the resin composition, and hence concerns are raised about deformation at the time of molding and long-term heat resistance. Further, there is a problem in that an external appearance failure occurs due to generation of gas upon molding.

Citation List

Patent Literature

[PTL 1] JP 2006-182994 A
[PTL 2] JP 2007-246845 A

DISCLOSURE OF THE INVENTION

Problems to be Solved by the Invention

[0005] An object of the present invention is to provide a thermoplastic resin composition which has remarkably improved flame retardancy and remarkably improved impact resistance without using any flame retardant agent, is excellent in chemical resistance and heat resistance and provides a molded article having a good external appearance, and a molded article using the thermoplastic resin composition.

Means for Solving the Problems

[0006] The inventors of the present invention have made extensive studies to achieve the above object. As a result, the inventors have found that the above object can be achieved by compounding a specific amount of a functional group-containing silicone compound into a resin composition based on an aromatic polycarbonate resin and an aliphatic polyester. The present invention has been completed on the basis of such finding.

[0007] That is, the present invention provides the following thermoplastic resin composition and molded article.

[0008] 1. A thermoplastic resin composition, comprising a combination of 5 to 89,95 mass % of an aromatic polycarbonate resin (A), 5 to 60 mass % of an aliphatic polyester (B), 5 to 30 mass % of talc (C), 0.05 to 3 mass % of a functional group-containing silicone (D), and 0 to 2 mass % of polyetherfluoretherlene (E) at a total content of the components (A) to (E) of 100 mass %, the thermoplastic resin composition being characterized in that a mass ratio of the component (D) to the component (B) is 0.003 to 0.6.

[0009] 2. The thermoplastic resin composition according to the above item 1, wherein the component (B) comprises at least one kind selected from a polyactic acid, copolymers of lactic acids and other hydroxy carboxylic acids, and polybutylene succinate.

[0010] 3. The thermoplastic resin composition according to the above item 1 or 2, comprising 5 to 50 mass % of a silicone-copolymerized polycarbonate as the component (A).

[0011] 4. The thermoplastic resin composition according to the above item 3, wherein a silicone of the silicone-copolymerized polycarbonate comprises a polyorganosiloxane.

[0012] 5. A molded article obtained by using the thermoplastic resin composition according to any one of the above items 1 to 4.

[0013] 6. A casing for an OA instrument, electrical and electronic instrument, or communication instrument, the casing being obtained by using the thermoplastic resin composition according to any one of the above items 1 to 4.

EFFECTS OF THE INVENTION

[0014] According to the present invention, there can be provided a thermoplastic resin composition having remarkably improved flame retardancy and remarkably improved impact resistance without using any flame retardant agent, and excellent in chemical resistance and heat resistance, and a molded article using the thermoplastic resin composition by compounding an aliphatic polyester and a functional group-containing silicone compound at a specific ratio into a resin composition based on an aromatic polycarbonate resin and an aliphatic polyester. Further, there can be provided a molded article having a good external appearance by an interaction between the functional group-containing silicone compound and the aliphatic polyester.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. 1 is a perspective view of a test piece-mounting jig for evaluating a composition of the present invention for its chemical resistance.

MODE FOR CARRYING OUT THE INVENTION

[0016] Hereinafter, the present invention is described in detail.

[0017] A thermoplastic resin composition of the present invention is a resin composition comprising an aromatic poly-
carbonate resin (A), an aliphatic polyester (B), talc (C), a functional group-containing silicone compound (D), and as required, polytetrafluoroethylene (E), and being characterized in that a mass ratio of the component (D) to the component (B) is 0.003 to 0.6.

[0018] Aromatic Poly carbonate Resin (A)

[0019] The thermoplastic resin composition of the present invention is a composition containing the aromatic poly carbonate resin (A) (which may hereinafter be abbreviated as “aromatic PC resin”).

[0020] The component (A) of the present invention is an aromatic PC resin having a terminal group represented by the following general formula (1).

![Chem1]

\[
\text{(1)}
\]

[0021] In the general formula (1), \( R' \) represents an alkyl group having 1 to 35 carbon atoms, the alkyl group may be linear or branched, and its bonding position, which may be any one of para, meta, and ortho positions, is preferably the para position, and a represents an integer of 0 to 5. The aromatic PC resin has a viscosity-average molecular weight of typically 10,000 to 40,000, preferably 13,000 to 30,000 in terms of the impartment of heat resistance, flame retardancy, and impact resistance, or more preferably 20,000 to 24,000.

[0022] It should be noted that the viscosity-average molecular weight (Mv) is a value calculated from an equation “\( n = 1.23 \times 10^{-3} M^0.83 \)” where \( n \) represents a limiting viscosity determined by measuring the viscosity of a methylene chloride solution at 20°C with an Ubbelohde viscometer.

[0023] The aromatic polycarbonate having the terminal group represented by the above general formula (1) can be easily produced by causing a dihydroxy phenol and phosgene or a carbonate compound to react with each other. That is, the aromatic polycarbonate is produced by, for example, a reaction between the dihydroxy phenol and a carbonate precursor such as phosgene or an ester exchange reaction between the dihydroxy phenol and a carbonate precursor such as diphenyl carbonate in a solvent such as methylene chloride in the presence of a catalyst such as triethylamine and a specific terminal stopper.

[0024] Examples of the dihydroxy phenol include compounds each represented by the following general formula (2).

![Chem2]

\[
\text{(2)}
\]

[0025] \( R^2 \) and \( R^3 \) each represent an alkyl group having 1 to 6 carbon atoms or a phenyl group, and may be identical to or different from each other. \( Z \) represents a single bond, an alkylene group having 1 to 20 carbon atoms, an alkyllidene group having 2 to 20 carbon atoms, a cycloalkylene group having 5 to 20 carbon atoms, a cycloalkylidene group having 5 to 20 carbon atoms, or a = —SO₂—, —SO₃—, —S—, —O—, or —CO— bond, or preferably an isopropylidene group, and \( b \) and \( c \) each represent an integer of 0 to 4, or preferably 0.

[0026] Examples of the above-mentioned dihydroxy phenol represented by the general formula (2) include: 4,4’-dihydroxydiphenyl, bis(5-hydroxyphenyl)alkanes such as 1,1’-bis(4-hydroxyphenyl)methane, 1,1’-bis(4-hydroxyphenyl)ethane, and 2,2-bis(4-hydroxyphenyl)propane; bis(4-hydroxyphenyl)cycloalkane; bis(4-hydroxyphenyl)oxide; bis(4-hydroxyphenyl)sulfide; bis(4-hydroxyphenyl)sulfone; bis(4-hydroxyphenyl)sulfoxide; bis(4-hydroxyphenyl)ketone; and the like. Of these, 2,2-bis(4-hydroxyphenyl)propane (bisphenol A) is preferred.

[0027] The dihydroxy phenol may be a homopolymer using one kind of the above dihydroxy phenols, or may be a copolymer using two or more kinds of them. Further, a thermoplastic, randomly branched polycarbonate obtained by using a polyfunctional aromatic compound and any one of the above dihydroxy phenols in combination is permitted.

[0028] Examples of the carbonate compound include: diaryl carbonates such as diphenyl carbonate; and dialkyl carbonates such as dimethyl carbonate and diethyl carbonate.

[0029] A phenol compound from which the terminal group represented by the general formula (1) is formed, that is, a phenol compound represented by the following general formula (3) has only to be used as the terminal stopper. In the following general formula (3), \( R' \) and \( a \) each have the same meaning as that described above.

![Chem3]

\[
\text{(3)}
\]

[0030] Examples of the phenol compound include phenol, p- cresol, p-tert-butylphenol, p-tert-pentylphenol, p-tert-oc-tylphenol, p-cumylphenol, p-nonylphenol, docooylphenol, tetracocoylphenol, hexacyclophenol, octococoylphenol, triacylphenol, dotriacontylphenol, tetriacontylphenol, or the like. One kind of the phenol compounds may be used alone, or two or more kinds thereof may be used in combination. In addition, any one of those phenol compounds may be used in combination with, for example, any other phenol compound as required.

[0031] It should be noted that the aromatic polycarbonate produced by the above method practically has the terminal group represented by the general formula (1) at one terminal, or each of both terminals, of any one of its molecules.

[0032] In the present invention, the aromatic PC resin as the component (A) preferably contains a silicone-copolymerized polycarbonate. In particular, the silicone of the silicone-copolymerized polycarbonate is preferably a polyorganosiloxane in terms of improvements in heat resistance, flame retardancy, and impact resistance.

[0033] In the case of, for example, an aromatic polycarbonate-polyorganosiloxane copolymer (which may hereinafter be referred to as “aromatic PC–POS copolymer”), the POS is more preferably a polydimethylsiloxane.
The aromatic PC—POS copolymer has a terminal group represented by the following general formula (4), and examples of the copolymer include copolymers disclosed in JP 50-29695 A, JP 03-29235 A, JP 04-202465 A, JP 08-81620 A, JP 08-302178 A, and JP 10-7897 A. In the following general formula (4), an alkyl group having 1 to 35 carbon atoms represented by $R^d$ may be linear or branched, and its bonding position, which may be any one of para, meta, and ortho positions, is preferably the para position, and $d$ represents an integer of 0 to 5.

Preferred examples of the aromatic PC—POS copolymer include copolymers each having, in any one of its molecules, a polycarbonate segment formed of a structural unit represented by the following general formula (5) and a polyorganosiloxane segment formed of a structural unit represented by the following general formula (6).

$R^s$ and $R^6$ each represent an alkyl group having 1 to 6 carbon atoms or a phenyl group, and may be identical to or different from each other, $R^7$ to $R^{10}$ each represent an alkyl group having 1 to 6 carbon atoms or a phenyl group, or preferably a methyl group, and $R^7$ to $R^{10}$ may be identical to or different from one another, and $R^{11}$ represents a divalent organic group containing an aliphatic or aromatic group, or preferably a divalent group represented by any one of the following formulae.

Examples of the phenol compound represented by the above general formula (7) used in the production of the aromatic PC—POS copolymer include the same compounds as the exemplified compounds of the general formula (3). The content of the above polyorganosiloxane segment is preferably 0.2 to 10 mass % with respect to the aromatic PC—POS copolymer, and is preferably 0.1 to 5 mass % in the thermoplastic resin composition of the present invention.

The PC oligomer used in the production of the aromatic PC—POS copolymer can be easily produced by, for example, a reaction between a dihydric phenol and a carbonate precursor such as phosgene or a carbonate compound, or an ester exchange reaction between the dihydric phenol and a carbonate precursor such as diphenyl carbonate in a solvent such as methylene chloride.

Here, any one of the same compounds as the exemplified compounds of the general formula (2) can be used as
the dihydric phenol, and 2,2-bis(4-hydroxyphenyl)propane (bisphenol A) out of the compounds is preferred. Any one of the same compounds as the exemplified compounds can be used as the carbonate compound.

[0042] In addition, the PC oligomer may be a homopolymer using one kind of the above dihydric phenols, or may be a copolymer using two or more kinds of them. Further, a thermoplastic, randomly branched polycarbonate obtained by using a polyfunctional aromatic compound and any one of the above dihydric phenols in combination is permitted.

[0043] In this case, as a branching agent (polyfunctional aromatic compound), there may be used 1,1,1-tris(4-hydroxyphenyl)ethane, $\alpha,\alpha',\alpha''$-tris(4-hydroxyphenyl)-1,3,5-triisopropylbenzene, $1\{\alpha$-methyl-$\alpha$-(4'-hydroxyphenyl)ethyl$\}1$-$4$-$[\alpha,\alpha'$-bis($4'$-hydroxyphenyl)ethyl]benzene, phloroglucine, trimellitic acid, isatinbis(o-cresol), or the like.

[0044] The aromatic PC—PO copolymer, which can be produced as described above, is generally produced as an aromatic polycarbonate containing a polycarbonate-polyorganosiloxane copolymer because an aromatic polycarbonate is produced as a by-product.

[0045] It should be noted that the aromatic PC—PO copolymer produced by the above method practically has the aromatic terminal group represented by the general formula (4) at one side, or each of both sides, of any one of its molecules.

[0046] The component (A) in the present invention is compounded at a content of 5 to 89.95 mass % in the total amount of the components (A) to (E). When the content is less than 5 mass %, reductions in flame retardancy and impact resistance are remarkable. When the content exceeds 89.95 mass %, moldability and chemical resistance reduce. The content is preferably 10 to 80 mass %, or more preferably 10 to 75 mass %.

[0047] In addition, when a silicone-copolymerized polycarbonate is compounded as the component (A), the component is compounded at a content of preferably 5 to 50 mass %, or more preferably 10 to 40 mass % in the total amount of the components (A) to (E).

[0048] [Aliphatic Polyester (B)]

[0049] At least one kind selected from a polylactic acid, copolymers of lactic acids and other hydroxyacrylic acids, and a polybutylene succinate is preferably used as the aliphatic polyester (B) of the present invention from the viewpoint of the reduction of an environmental load.

[0050] The polylactic acid is typically synthesized from a cyclic dimer of lactic acid called a lactide by ring-opening polymerization. A production method for the polylactic acid is disclosed in, for example, U.S. Pat. No. 1,995,970 A, U.S. Pat. No. 2,362,511 A, or U.S. Pat. No. 2,683,136 A.

[0051] In addition, the copolymers of the lactic acids and the other hydroxyacrylic acids are each typically synthesized from the lactide and a cyclic ester intermediate of a hydroxyacrylic acid by ring-opening polymerization. A production method for each of the copolymers is disclosed in, for example, U.S. Pat. No. 3,635,956 A or U.S. Pat. No. 3,797,499 A.

[0052] When a lactic acid-based resin is directly produced by dehydration condensation without reliance on ring-opening polymerization, a lactic acid-based resin having a degree of polymerization suitable for the present invention is obtained by polymerization according to the following method. That is, any one of the lactic acids, and as required, any other hydroxyacrylic acid are subjected to azeotropic dehydration condensation in the presence of preferably an organic solvent, or especially a phenyl ether-based solvent. Further, water is particularly preferably removed from the solvent as a distillate obtained by the azeotropy, and the solvent brought into a substantially anhydrous state is returned to a reaction system.

[0053] Any one of L- and D-lactic acids, a mixture of the lactic acids, and the lactide as the dimer of lactic acid can be used as one of the lactic acids as raw materials.

[0054] In addition, examples of the other hydroxyacrylic acids that can be used in combination with the lactic acids include glycolic acid, 3-hydroxybutyric acid, 4-hydroxybutyric acid, 4-hydroxyvaleric acid, 5-hydroxyvaleric acid, and 6-hydroxy-caproic acid. Further, cyclic ester intermediates of hydroxyacrylic acids such as glycolide as the dimer of glycolic acid and $\epsilon$-caprolactone as the cyclic ester of 6-hydroxy-caproic acid can each be used.

[0055] Upon production of the lactic acid-based resin, a proper additive such as a molecular weight modifier, a branching agent, or any other modifying agent can also be compounded.

[0056] One kind of the lactic acids may be used alone, or two or more kinds of them may be used in combination. The same holds true for the hydroxyacrylic acids as copolymer components. Further, two or more kinds of the resultant lactic acid-based resins may be used as a mixture.

[0057] Natural product-derived polylactic acids are excellent candidates for the aliphatic polyester as the component (B) used in the present invention because of their fluidity, and thermal and mechanical properties. Of those, one having a weight-average molecular weight of 30,000 or more is preferred. The term “weight-average molecular weight” as used herein refers to a molecular weight measured by gel permeation chromatography in terms of polymethyl methacrylate (PMMA).

[0058] The component (B) in the present invention is compounded at a content of 5 to 60 mass % in the total amount of the components (A) to (E). When the content is less than 5 mass %, the chemical resistance and fluidity are insufficient. When the content is 60 mass % or more, the heat resistance and the impact resistance reduce. The content is preferably 10 to 60 mass %, or more preferably 20 to 50 mass %.

[0059] [Talc (C)]

[0060] The thermoplastic resin composition of the present invention is a resin composition containing the talc (C). The incorporation of the component (C) can improve the flame retardancy.

[0061] The talc as the component (C) in the present invention is a water-containing silicate of magnesium, and a general commercially available product can be used as the component. The component is preferably of a plate shape, though its shape is not particularly limited to such an extent that an object of the present invention is achieved.

[0062] Further, the component (C) preferably has an average particle diameter of 0.1 to 50 $\mu$m. One having an average particle diameter of 0.2 to 20 $\mu$m is particularly suitably used.

[0063] The component (C) in the present invention is compounded at a content of 5 to 30 mass % in the total amount of the components (A) to (E). When the content is less than 5 mass %, the flame retardancy cannot be imparted. When the content exceeds 30 mass %, the flame retardancy cannot be imparted, and moreover, the impact resistance becomes insufficient. The content is preferably 5 to 25 parts by mass, or more preferably 10 to 25 parts by mass.
The thermoplastic resin composition of the present invention is a resin composition containing the functional group-containing silicone compound (D). When the resin composition contains the component (D), a molded article having improved flame retardancy, improved impact resistance, and a good external appearance can be obtained.

The component (D) in the present invention is preferably a functional group-containing organopolysiloxane compound, and examples of the compound include organopolysiloxane polymers and/or copolymers each having a basic structure represented by the following general formula (8).

\[ R^{13}_g R^{13}_h SiO_{a+b} \quad (8) \]

(In the formula, \( R^{12}_g \) represents a functional group, \( R^{13}_h \) represents a hydrocarbon group having 1 to 12 carbon atoms, and \( g \) and \( h \) represent numbers satisfying the relationships of \( 0 \leq g \leq 3 \), \( 0 \leq h \leq 3 \), and \( g + h \leq 3 \).)

The compound contains an alkoxy group, an alkoxy group, a polyoxyalkylene group, a hydroxyl group, a hydroxyl group, a mercapto group, an epoxy group, a vinyl group, or the like as a functional group. Of those, an alkoxy group, a hydroxyl group, a hydroxyl group, an epoxy group, and a vinyl group are preferably used.

Organopolysiloxane polymers and/or copolymers each having a plurality of functional groups, and organopolysiloxane polymers and/or copolymers each having different functional groups can also be used in combination as these functional groups.

Organopolysiloxane polymers and/or copolymers each having a basic structure represented by the above general formula (8) are each such that a molar ratio “functional group (R12)/hydrocarbon group (R13)” is preferably 0.1 to 3, or preferably about 0.3 to 2.

Those functional group-containing silicone compounds, which are liquids, powders, and the like, each preferably have good dispersibility in melting and kneading.

Examples of such compounds include liquid compounds each having a dynamic viscosity at room temperature of about 10 to 500,000 mm²/sec.

The thermoplastic resin composition of the present invention has the following characteristics. That is, even when the functional group-containing silicone compound is a liquid, the compound is uniformly dispersed in the resin composition, and bleeds to a small extent at the time of molding or to the surface of the molded article.

The component (D) in the present invention is compounded at a content of 0.05 to 3 mass % in the total amount of the components (A) to (E). When the content is less than 0.05 mass %, improving effects on, for example, the flame retardancy and the impact resistance cannot be expressed. When the content exceeds 3 mass %, the impact resistance reduces and an external appearance upon molding deteriorates. The content is preferably 0.1 to 2.5 mass %, or more preferably 0.3 to 2.5 mass %.

Further, in the present invention, a mass ratio of the component (D) to the component (B) “component (D)/component (B)” must be 0.003 to 0.6. When the ratio is less than 0.003, the flame retardancy cannot be imparted, the impact resistance and the heat resistance become insufficient, and the external appearance upon molding deteriorates. When the ratio exceeds 0.6, the impact resistance reduces and the external appearance upon molding deteriorates. The ratio is preferably 0.005 to 0.3, or more preferably 0.01 to 0.2.

The polytetrafluoroethylene (E) can be added to the thermoplastic resin composition of the present invention as required. The incorporation of the component (E) can impart a molten drip-preventing effect and improve the flame retardancy.

The component (E) in the present invention is not particularly limited as long as the component has a fibril-forming ability. The term “fibril-forming ability” used herein refers to such a tendency that the molecules of the resin are bonded to each other so as to be of a fibrous shape by an external action such as a shearing force. Examples of the component (E) of the present invention include a polytetrafluoroethylene and a tetrafluoroethylene-based copolymer (such as a tetrafluoroethylene/hexafluoropropylene copolymer). Of those, the polytetrafluoroethylene is preferably used.

A PTFE having the fibril-forming ability has an extremely large molecular weight, and its number-average molecular weight determined from a standard specific gravity is typically 500,000 or more, or preferably 500,000 to 10,000,000. To be specific, the PTFE can be obtained by polymerizing tetrafluoroethylene in an aqueous solvent in the presence of sodium, potassium, or ammonium peroxysulfide under a pressure of about 7 to 700 kPa at a temperature of about 0 to 200°C, or preferably 20 to 100°C.

In addition, a PTFE in the form of an aqueous dispersion as well as a solid can be used, and one classified into Type 3 according to the ASTM standard can be used. Commercially available products classified into Type 3 are, for example, a Teflon (registered trademark) 6-J (trade name, manufactured by Du Pont-Mitsui Fluorochemicals Company, Ltd.), and a Polyflon D-1 and a Polyflon F-103 (trade names, manufactured by Daikin Industries, Ltd.). In addition, commercially available products classified into types except Type 3 are, for example, an Algoflon F5 (trade name, manufactured by Montefluos) and a Polyflon MPAPA-100 (trade name, manufactured by Daikin Industries, Ltd.).

One kind of the above PTFEs each having the fibril-forming ability may be used alone, or two or more kinds of them may be used in combination.

The component (E) in the present invention is preferably added at a content of about 0 to 2 mass % in the total amount of the components (A) to (E). The component (E) is added for additionally improving the flame retardancy of the thermoplastic resin composition of the present invention. However, no larger improving effect on the flame retardancy is obtained even when the component is added at a content in excess of 2 mass %. As long as the content is 2 mass % or less, pellets can be stably produced because the impact resistance and moldability (external appearance of a molded article) of the resin composition do not risk being adversely affected, and the resin composition can be favorably ejected even at the time of kneading extrusion.

Silica can be added to the thermoplastic resin composition of the present invention as required. The addition of the silica can improve the flame retardancy.

The silica to be added is preferably a high-purity anhydrous silica preferably having an SiO₂ content of more than 99.5%, an average particle diameter of 50 nm or less, and a specific surface area of about 50 to 400 m²/g. Such silica is...
easily available as aerosil or colloidal silica. However, the component is not particularly limited as long as the component is such silica as described above.

In the present invention, the silica is preferably added at a content of about 0 to 1 mass % in the thermoplastic resin composition. When the content exceeds 1 mass %, an improving effect on the flame retardancy cannot be expressed.

Alternatively, a product prepared by dispersing the silica in a solvent such as water or ethylene glycol at a content of about 5 to 50 mass % can also be used.

[Additive and Inorganic Filler]

Any other synthetic resin or elastomer, and furthermore, various additives such as an antioxidant, a UV absorber, a light stabilizer, any other flame retardant agent, and a lubricant, other various inorganic fillers, and the like can each be appropriately incorporated into the thermoplastic resin composition of the present invention in addition to the above components (A) to (E) and silica as required to such an extent that an object of the present invention is not impaired.

[Pelletization]

The thermoplastic resin composition of the present invention can be obtained by: compounding the aromatic polycarbonate resin (A), the aliphatic polyester (B), the talc (C), and the functional group-containing silicone compound (D), and the polytetrafluoroethylene (E), silica, and an additive, and an inorganic filler to be used as required according to an ordinary method; and melting and kneading the mixture. The compounding and the kneading in this case can each be performed with an instrument that is typically used such as a ribbon blender, a Henschel mixer, a Banbury mixer, a drum tumbler, an uniaxial screw extruder, a biaxial screw extruder, a co-kneader, or a multi-axial screw extruder. A proper heating temperature in the melting and kneading is typically 240 to 280°C.

[Molded Article Using Thermoplastic Resin Composition]

The thermoplastic resin composition of the present invention can be turned into a molded article by applying a known molding method such as hollow molding, injection molding, extrusion molding, vacuum molding, air-pressure molding, heat bending molding, compression molding, cylinder molding, or rotational molding. In particular, the thermoplastic resin composition of the present invention is excellent in flame retardancy and heat resistance, and can provide a molded article having good external appearance upon molding. Accordingly, the thermoplastic resin composition is suitably used in sites requested to have those characteristics such as parts for OA instruments, electrical and electronic instruments, and communication instruments, and can be utilized in the fields of, for example, optical members and automobiles.

That is, the present invention also provides a molded article obtained by using the thermoplastic resin composition of the present invention, or especially a casing for an OA instrument, electrical and electronic instrument, or communication instrument.

EXAMPLES

The present invention is described in more detail by way of examples. However, the present invention is by no means limited by these examples.

The components (A) to (E) used in Examples 1 to 15 and Comparative Examples 1 to 13 below are as described below.

(A) Aromatic Polycarbonate Resin

(A1900: A bisphenol A polycarbonate A1900 (manufactured by Idemitsu Kosan Co., Ltd.) having a viscosity-average molecular weight of 19,000

(0098) PC—POS copolymer: An aromatic polycarbonate-polyorganosiloxane copolymer having a viscosity-average molecular weight of 17,000 and a polydimethylsiloxane content of 4.0 mass %, and prepared in conformity with Production Example 4 of JP 2002-12755 A

(B) Aliphatic Polyester

3001D: A polylactic resin (manufactured by Natureworks LLC)

GSP1a: A polybutylene succinate, AZ81T (manufactured by Mitsubishi Chemical Corporation)

(C) Talc

Talc 1: ATP-A25 (manufactured by Fuji Tale Industrial Co., Ltd.)

Talc 2: An HT-7000 (manufactured by Harima Chemicals, Inc.)

(D) Functional Group-Containing Silicone Compound

Silicone 1: methyl phenyl silicone containing vinyl group and methoxy group, KR511 (manufactured by Shin-Etsu Chemical Co., Ltd.)

Silicone 2: methyl hydrogen silicone, KF-99 (manufactured by Shin-Etsu Chemical Co., Ltd.)

Silicone 3 (Comparison): silicone having no functional group, SH200 (manufactured by Dow Corning Toray Co., Ltd.)

(E) Polytetrafluoroethylene

PTFE: A CD076 (manufactured by ASAHI GLASS CO., LTD.)

Examples 1 to 15 and Comparative Examples 1 to 13

After the respective components (A) to (E) had been dried, the respective components were compounded at a ratio shown in each of Tables 1 and 2, and were then uniformly blended with a tumbler. After that, the mixture was supplied to a biaxial extruder with a vent having a diameter of 55 mm (TOSIBA MACHINE CO., LTD., model name: TEM353), and was then kneaded at a temperature of 260°C so as to be pelletized.

The resultant pellets were dried at 120°C for 5 hours. After that, the pellets were subjected to injection molding with an injection mold at a cylinder temperature of 240°C and a mold temperature of 80°C. Thus, test pieces were obtained.

The physical properties of the resultant test pieces were measured and evaluated by the following methods. Tables 1 and 2 show the results.

<Measurement and Evaluation of Physical Properties of Resin Composition>

(1) Flame Retardancy

A vertical flame test was performed with test pieces each having a thickness of 1.2 mm or 1.5 mm produced in conformity with the UL standard 94. The test pieces were evaluated for their grades of the UL 94 flammability classes (V-0, V-1, and V-2 in order of decreasing flame retardancy) on
the basis of the results of the test, and those not corresponding to these flammability classes were regarded as being non-standard.

(2) External Appearance

A square plate measuring 140 mm long by 140 mm wide by 3 mm thick was molded and visually observed. The case where the square plate was free of any flow mark or silver was represented by o, the case where a flow mark or silver was slightly observed was represented by A, and the case where an external appearance failure such as silver occurred was represented by x.

(3) IZOD Impact Strength (IZOD)

Measurement was performed with a test piece having a thickness of 3.2 mm (1/8 inch) produced with an injection molder in conformity with the ASTM standard D-256.

(4) Chemical Resistance

Evaluation was performed in conformity with a chemical resistance evaluation method (critical strain with a quarter ellipse). A test piece (having a thickness of 3 mm) was fixed to a surface of the quarter ellipse illustrated in FIG. 1 (perspective view). Gasoline (Zearth manufactured by Idenitsu Kosan Co., Ltd.) was applied to the test piece, and was then held for 48 hours. The minimum length (X) at which a crack was generated was read, and then the critical strain (%) was determined from the following equation [1]. It should be noted that t in the following equation [1] represents the thickness of the test piece. A larger critical strain (%) means a higher chemical resistance.

\[
\text{Critical strain} (%) = \frac{b}{2a^2} \left[ 1 - \left( \frac{1 - \frac{b^2}{a^2}}{\pi^2} \right)^{1/2} \right]
\]

(5) Heat Resistance (Deflection Temperature Under Load)

A deflection temperature under load was measured in accordance with a measurement method described in JIS K 7191 under a load of 1.8 MPa at a temperature of 23°C.

| TABLE 1 |
|-----------------|---|---|---|---|---|---|---|
| Compounding ratio | Example | 1 | 2 | 3 | 4 | 5 | 6 |
| (A) A1900 (%)* | 29.1 | 29.25 | 27.5 | 29.7 | — | — | — |
| PC-POS copolymer (%)* | 30 | 30 | 30 | 30 | 12.5 | 13.5 | 12.5 |
| (B) 3001D (%)* | — | 20 | 30 | 30 | 60 | 60 | — |
| GSP1a (%)* | — | — | — | 10 | 15 | 25 | 25 |
| (C) Talc 1 (%)* | — | — | — | — | 60 | — | — |
| Talc 2 (%)* | — | — | — | — | 30 | 10 | — |
| (D) Silicone 1 (%)* | 0.5 | 0.75 | — | — | 0.3 | 1.5 | — |
| Silicone 2 (%)* | — | — | — | — | — | — | — |
| Silicone 3 (comparison) (%)* | — | — | — | — | — | — | — |
| (D)/(B) (mass ratio) | 0.0167 | 0.0250 | 0.0833 | 0.0100 | 0.0417 | 0.0250 | 0.0417 |
| (E) PTFE (%)* | 0.4 | — | — | — | — | — | — |
### TABLE 1-continued

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Flame retardancy (Thickness 1.2 mm)</th>
<th>V-1</th>
<th>V-1</th>
<th>V-1</th>
<th>V-1</th>
<th>V-1</th>
<th>V-1</th>
<th>V-1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(2) External appearance (visual observation)</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td></td>
<td>(3) IZOD impact strength (kJ/m²)</td>
<td>58</td>
<td>65</td>
<td>50</td>
<td>45</td>
<td>30</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>(4) Chemical resistance (critical strain) [%]</td>
<td>1.4</td>
<td>1.4</td>
<td>1.2</td>
<td>1.2</td>
<td>1.6</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>(5) Heat resistance (under a load of 1.8 MPa) [°C]</td>
<td>120</td>
<td>119</td>
<td>120</td>
<td>120</td>
<td>95</td>
<td>98</td>
<td>90</td>
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</table>

(%)* Mass %

### TABLE 2

<table>
<thead>
<tr>
<th>Compounding ratio</th>
<th>Comparative Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) A1900 (%)*</td>
<td>77.5 37.5 30 29.6 9.7 25</td>
</tr>
<tr>
<td>PC-POS copolymer (%)*</td>
<td>10 30 30 30 55 10 30</td>
</tr>
<tr>
<td>(B) 3001D (%)*</td>
<td>2 30 30 30 20 30 30</td>
</tr>
<tr>
<td>GSPIa (%)*</td>
<td>— — — — — —</td>
</tr>
<tr>
<td>(C) Tale 1 (%)*</td>
<td>10 2 10 10 10 50 10</td>
</tr>
<tr>
<td>Tale 2 (%)*</td>
<td>— — — — — —</td>
</tr>
<tr>
<td>(D) Silicone 1 (%)*</td>
<td>0.5 0.5 — — 15 0.3 5</td>
</tr>
<tr>
<td>Silicone 2 (%)*</td>
<td>— — — — — —</td>
</tr>
<tr>
<td>Silicone3 (comparison) (%)*</td>
<td>— — — — — —</td>
</tr>
<tr>
<td>(D)/(B) Mass ratio</td>
<td>0.2500 0.0167 — — 0.75 0.0100 0.1667</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Flame retardancy (Thickness 1.2 mm)</th>
<th>V-0</th>
<th>Nonstandard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(2) External appearance (visual observation)</td>
<td>o</td>
<td>Δ</td>
</tr>
<tr>
<td></td>
<td>(3) IZOD impact strength [kJ/m²]</td>
<td>60 40 5 5 20 10 40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(4) Chemical resistance (critical strain) [%]</td>
<td>0.2 1.2 0.8 0.8 0.8 0.6 0.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(5) Heat resistance (under a load of 1.8 MPa) [°C]</td>
<td>130 115 115 118 100 120 110</td>
<td></td>
</tr>
</tbody>
</table>

(%)* Mass %
Tables 1 and 2 show the following.

1. Examples 1 to 15

The present invention enabled the provision of a thermoplastic resin composition having improved flame retardancy and improved impact resistance, and excellent in balance among properties including chemical resistance and heat resistance. Further, the use of the thermoplastic resin composition of the present invention enabled the provision of a molded article having less external appearance failure.

2. Comparative Example 1

As can be seen from Comparative Example 1 shown in Table 2, the chemical resistance of a resin composition cannot be obtained when the amount in which the aliphatic polyester (B) is compounded is small.

3. Comparative Examples 2 to 11

As can be seen from Comparative Examples 2 to 11 shown in Table 2, the flame retardancy, the impact resistance, the chemical resistance, and the heat resistance of a resin composition are insufficient as when the amount in which each of the components (A) to (D) is compounded deviates from the range specified in the present invention.

4. Comparative Examples 12 and 13

As can be seen from Comparative Examples 12 and 13 shown in Table 2, the use of a silicone having no functional group significantly reduces the flame retardancy and the impact resistance, and slightly reduces the heat resistance as well.

INDUSTRIAL APPLICABILITY

The thermoplastic resin composition of the present invention has improved flame retardancy and improved impact resistance by using a polylactic acid or the like as a polyester resin without using any flame retardant agent. In addition, the thermoplastic resin composition of the present invention is excellent in chemical resistance and heat resistance, and can provide a molded article having a good external appearance upon molding. Accordingly, the thermoplastic resin composition can be widely used in the fields of, for example, optical members and automobiles. Further, the thermoplastic resin composition can be suitably used in the production of casings for OA instruments, electrical and electronic instruments, and communication instruments.

Description of Symbols

a: bottom length of quarter ellipse jig
b: height of quarter ellipse jig
X: distance to position at which crack is generated
Y: test piece (having thickness of 3 mm)

1. A thermoplastic resin composition, comprising a combination of 5 to 89.95 mass % of an aromatic polycarbonate resin (A), 5 to 60 mass % of an aliphatic polyester (B), 5 to 30 mass % of talc (C), 0.05 to 3 mass % of a functional group-containing silicone (D), and 0 to 2 mass % of polytetrafluoroethylene (E) at a total content of the components (A) to (E) of 100 mass %, the thermoplastic resin composition being characterized in that a mass ratio of the component (D) to the component (B) is 0.003 to 0.6.

2. The thermoplastic resin composition according to claim 1, wherein the component (B) comprises at least one kind selected from a polylactic acid, copolymers of lactic acids and other hydroxy carboxylic acids, and a polybutylene succinate.

3. The thermoplastic resin composition according to claim 1 or 2, comprising 5 to 50 mass % of a silicone-copolymerized polycarbonate as the component (A).

4. The thermoplastic resin composition according to claim 3, wherein a silicone of the silicone-copolymerized polycarbonate comprises a polyorganosiloxane.

5. A molded article obtained by using the thermoplastic resin composition according to any one of claims 1 to 4.

6. A casing for an OA instrument, electrical and electronic instrument, or communication instrument, the casing being obtained by using the thermoplastic resin composition according to any one of claims 1 to 4.

* * * * *